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Abstract

This report provides a new economic approach and methodology for analyzing nutritional quality change in manufacturers' food product offerings and food products purchased using a case study of five food product categories in the mid-1990's. Two approaches were used to analyze nutritional quality change in product offerings. The first approach uses a composite nutritional index to measure changes. A second approach, nutrient-by-nutrient analysis, was also used to measure quality change. Overall, the nutrition index analysis showed no significant change in the average nutritional quality of products offered for sale in the five categories.

Keywords: Nutrition quality, quality index, quality, food product offerings, nutrition labeling.

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Contents

List of Tables

Summary

Several studies have recently suggested strong growth in the availability of nutritionally improved versions of foods in U.S. supermarkets. These analyses are based on scanner data, where nutrition information was coded from the front panel of the product's package. Individual food products were considered to be nutritionally improved if they carried front-panel claims about reductions or increases in the level of specific nutrients. However, these studies do not directly quantify changes in the nutritional quality of food products offered for sale and purchased over time.

This report provides a new economic approach and methodology for analyzing nutritional quality change in manufacturers' food product offerings and food products purchased through a case study of five selected categories in the mid-1990's. It uses data from a complete census of all product offerings in a uniform package size in a supermarket in New England for each of the years 1992-95 and 1997. These data were developed at the University of Massachusetts to track the evolution of product offerings and nutrition label content in this period of regulatory change. To supplement the supermarket data, scanner-based national sales data were used to calculate preliminary measures of nutritional quality change in foods that were actually purchased in the marketplace.

Two approaches were used to measure nutritional quality change in product offerings in the five selected food categories: entrees, soup, salted snacks, cookies, and processed meats and bacon. The selected categories ranged across a spectrum from high to medium levels of formulation and represented foods that are important in consumer diets. In the first approach, the composite nutritional quality index developed by Padberg and others was used to measure nutritional quality changes. Calculation of the index requires complete nutrient data, which was frequently missing from product packages prior to the implementation of mandatory labeling in 1994. Because of the lack of data for earlier years, analysis for the years 1992-97 was possible for only processed meats and bacon, with the analysis of entrees, salted snacks, and cookies covering 1994-97 and the analysis of soup covering 1995-97. A second approach, nutrient-by-nutrient analysis, was also used to measure quality change.

Overall, the nutrition index analysis showed no significant change in the average nutritional quality of products offered for sale in the five categories. For entrees and cookies, the changes in the mean values of the nutrition indexes for products offered for sale were negative, which would suggest that the average nutritional quality of these foods decreased in the period 1994-97. For soup in 1995-97, salted snacks in 1994-97, and processed meats and bacon in 1992-97, the changes in the indexes were positive, which would suggest that the average nutritional quality of these products increased. However, in all of the categories considered, the changes in the nutrition indexes were statistically insignificant. For the processed meats and bacon category, the pace and direction of nutritional quality change was the same before and after the implementation of the Nutrition Labeling and Education Act in 1994.

Investigation of changes in the content of individual nutrients revealed similar trends and supported the findings from the nutrition index analysis. The only significant changes at the 95-percent level were in saturated fat and vitamin A in salted snacks, and in carbohydrates, vitamin A, calcium, and iron in processed meats and bacon. At the 90-percent level, the only significant changes were in vitamin A in soup, in fat in salted snacks, in fiber and protein in cookies, and in saturated fat and protein in processed meats and bacon. If changes in nutrient content were significant, increases in desirable nutrients were offset by increases in undesirable nutrients or decreases in undesirable nutrients followed decreases in desirable nutrients. Further analysis of the index results showed that both entering and exiting brands had higher nutritional quality indexes than the category as a whole. This finding is consistent with the finding that, overall, the average nutritional quality of foods offered for sale did not change much in the years examined, although nutrition indexes were higher than average for products entering the market.

To analyze changes in nutritional quality for foods actually purchased by consumers, the nutrition indexes for individual brands were weighted by scanner-based market share data. The results of this analysis are preliminary due to difficulties in matching products from the nutritional content data set with those in the national sales data set. For the set of products analyzed, the market share-weighted index values were lower than their unweighted counterparts. This finding suggests that, within the food categories, the relatively less healthful products had higher sales. In addition, separating entree and cookie brands into products with above- and below-average nutritional quality provided evidence that supported a decline in the proportion of relatively more healthful products sold. Market share-weighted indexes for soup, salted snacks, and processed meats suggest improvements in the average nutritional quality of products purchased in these food categories.

Market activity was high during the mid-1990's, around the introduction of nutritionally improved foods. This analysis indicates that, for the five food categories of entrees, soup, salted snacks, cookies, and processed meats and bacon, this market activity did not significantly change the average nutritional quality of food products offered for sale by manufacturers or, in preliminary results, the food products purchased by consumers.

Changes in Nutritional Quality of Food Product Offerings and Purchases

A Case Study in the Mid-1990's

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Introduction

Interest in human nutrition has been growing in recent years in the United States. The general public is now much more aware of the importance of the relationship between diet and health. Manufacturers and retailers have had to take account of this awareness in deciding on the composition, labeling, and marketing of foods.

In several recent studies, researchers have reported rapid growth in the market for nutritionally improved foods relative to regular versions of the same products, using supermarket scanner data (Frazão and Allshouse, 1996; *The Food Institute Report*, 1997). Frazão and Allshouse, for example, used nutrition content claims coded from a product's front panel, included in a national supermarket scanner data base, to analyze this trend. An individual food product was considered to be a "nutritionally improved version" if its front panel carried claims about reductions in the level of specific undesirable nutrients or increases in desirable nutrients. These studies suggested strong growth in the availability of nutritionally improved versions of foods in supermarkets. They did not, however, directly quantify nutritional quality or changes in quality over time.

This study quantifies nutritional quality change for five selected food categories. Results are presented on both product offerings and a measure of products purchased for one category (processed meats and bacon) for 1992-97, for three categories (entrees, salted snacks, and cookies) for 1994-97, and for one category (soup) for 1995-97. Two methods are used to measure nutritional quality change among products offered for sale by manufacturers in these categories. The first method uses a nutritional quality index developed by Padberg and others (1993) that is a composite measure of the nutritional quality of products. The second method is a measure of nutrient-by-nutrient changes in product offerings within the five categories. These indexes and nutrient content levels are then compared to construct simple measures of nutritional quality change over time.

The basic data set on the nutritional content of food products used in this analysis is for a complete census of all products offered for sale in a uniform package size in the food categories studied in a superstore in New England for each of the years

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1992-95 and 1997.[1] While this data set does not contain all products offered for sale in a particular year in the United States, it does provide broad coverage of the categories studied. The data are part of an ongoing survey, conducted at the University of Massachusetts, Amherst, that is designed to track the evolution of product offerings and label content in this period of market and regulatory change.

In addition to the superstore data on nutrition content, national sales data are used to calculate measures of change in the Padberg nutrition index weighted by market share. This approach provides a preliminary measure of the nutritional quality of food products actually purchased by consumers, which can be compared with changes in the nutritional quality of products offered for sale.

Changing Regulatory Regimes

The regulatory environment controlling food manufacturers' communication of nutritional attributes to consumers through labeling changed dramatically from partial controls in the 1970's and 1980's to a much stricter and mandatory nutrition labeling system beginning in 1994. The Nutrition Labeling and Education Act (NLEA) regulations require mandatory nutrition information panels for almost all packaged food. In addition, they require a new format for the nutrition information panel called "Nutrition Facts," standardization of serving sizes, and strict regulation of the use of descriptors and explicit health messages. Nutrition labeling remains on a voluntary basis for raw food stuffs (primarily fruits, vegetables, and meats) though grocery stores are required to post general nutrition information at the point of sale.

The new labeling regulations, as implemented by the Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA), changed the nutrients that must be listed on the redesigned "Nutrition Facts" panel. The new nutrient list emphasizes fats, sodium, and cholesterol, and thus reflects transformed health concerns and dietary patterns. Information on nutrient content is presented in quantitative amounts and as percentages of standardized dietary reference values, stated as "Percentage of Daily Value." Also, the listings in the "Nutrition Facts" panel are based on standardized serving sizes to help consumers understand and compare the nutritional values of different foods. As a result, serving sizes should be consistent across product categories and closer to the amounts people actually consume.

The poor diets of a significant proportion of the population, acknowledged by Federal health agencies, encouraged this labeling regulation. In practice, food labels impact product formulation, advertising, consumer confidence in food quality, and consumer education on diet and health, thus offering real health benefits to the general population and potentially improving economic efficiency and welfare (Caswell and Padberg, 1992).

Research Objective

The mid-1990's were an era of important change in markets for nutritional attributes. Rising consumer interest was coupled with extensive changes in nutrition labeling regulations, with nutrition labeling becoming mandatory for most products in 1994.

Improvements in nutrient intake of the population depend on the interaction of demand and supply forces in food markets. On the demand side, consumers' interest in and purchase of diets and products with improved nutritional profiles have a direct effect on nutrient intake. Consumers' ability to choose their diets partly depends on the quantity and quality of information available through a variety of sources, including food labels. On the supply side, Americans' diets may be affected by shifts in the composition of food product offerings. Here, too, change in the information environment may interact with demand factors to influence the mix and formulation of product offerings.

Information disclosure requirements on the nutritional quality of food are likely to significantly affect demand patterns and dynamics of food markets. Because access to information about product nutritional quality improved, products with less desirable nutrition profiles may reformulate. Also, rivalry between manufacturers may affect product design, even when a small number of consumers use labels (Caswell and Padberg, 1992).

The main objective of this research is to investigate changes in the average nutritional quality of food products offered for sale by manufacturers and food

[1]Data collection was funded by a USDA Cooperative State Research, Education, and Extension Service (CSREES) Special Grant to the Food Marketing Policy Center, University of Connecticut, and by subcontract at the University of Massachusetts, Amherst.

products purchased by U.S. consumers in the mid-1990's. This requires identifying effective methodologies for measuring the nutritional quality of food products. These methods can then be used to track quality change over time. To date, very few studies address the nutritional quality of food product offerings and food products purchased or the effect of changes in labeling regulations on the food supply. Exceptions have focused on changes in specific nutrients. For example, Ippolito and Mathios (1990) found that producers' new ability to make health claims about fiber led to significant product innovation and development in the ready-to-eat cereal industry in the 1980's, with fiber content increasing without adverse effects on other nutrient characteristics. In addition, Ippolito and Mathios (1996) found that fat and cholesterol consumption fell during the years 1977-90 and fell more rapidly after 1985 when health-related claims became more explicit and frequent in advertising for food products. Little work has been published, however, on overall changes in the nutritional quality of products offered for sale and purchased in the United States. This study addresses this supply-side gap in the food marketing literature.

Methods of Measuring the Nutritional Quality of Food Products

Several basic considerations must be taken into account when selecting a methodology to measure nutritional quality. Such measures can focus on a nutrient-by-nutrient analysis of a food product or on computing an index of overall nutritional quality. Both approaches can yield important information. In the latter case, some technique of unit standardization for the different nutrients has to be applied. In addition, this process of standardization has to transform the levels of nutrients to relate them to dietary recommendations. Finally, the difficult issue of the relative importance of different nutrients has to be considered.

In the literature, researchers have constructed and used four basic indexes to measure the nutritional value of food products. These indexes were developed by Hansen and others (1979), Mojduszka (1997), Moorman (1998), and Padberg and others (1993). In addition, the Healthy Eating Index was developed to measure how well American diets conform to recommended healthy eating patterns (USDA, CNPP, 1995). Each of these indexes deals with the nutrition measurement problems outlined above in a somewhat different way.

Hansen's Nutritional Quality Index

Hansen and others (1979) developed a nutrient-by-nutrient approach to measuring nutritional quality. Their index focuses on the amounts of the specific nutrients in a food relative to the amount of calories it contains. In order to compute such an index, nutrient standards must be determined. In their work, the amounts of the U.S. Recommended Daily Allowances for each nutrient were considered as the standards. Then the nutritional quality index of a specific nutrient was calculated as the ratio of its percentage standard relative to its percentage standard of calories. An index was computed in this form for each nutrient in a food product.

Hansen's nutritional index measures quality in terms of each nutrient contained in a food relative to its calorie level. It does not measure the overall nutritional quality of a food product. For example, for calories in any food, the index will always be unity. For a desirable nutrient, such as fiber or protein, a product with an index of 1 or greater will be of high quality. For an undesirable nutrient, such as fat, saturated fat, or cholesterol, the index has the opposite meaning: a value less than one indicates better nutritional quality.

Mojduszka's Hedonic Nutritional Quality Index

Quality measurement methodology in the economics literature relies heavily on the hedonic pricing approach. Therefore, Mojduszka (1997) investigated the usefulness of the hedonic pricing technique for measuring changes in the nutritional quality of packaged foods offered for sale in the period 1992-95. The methodology used a regression equation with prices of different products as the dependent variable and the nutritional characteristics of those products as the independent variables. The estimated coefficients provide the marginal values of the individual nutritional attributes. These in turn can be multiplied by observed amounts of each nutrient to compute the marginal monetary values of these nutrients. The sum of the marginal monetary values of individual nutrients yields the hedonic index of nutritional quality. To compute nutritional quality change over time, Laspeyre's or Paasche quantity change indexes are used.

The hedonic quality measurement method poses several problems when applied to measuring objective changes in nutritional quality. The most serious is that hedonic indexes are based on consumer valuation of the nutritional characteristics of food products. Consumers' valuation of nutrients can be inconsistent with the recommendations of dietary guidelines. For example, an increase in the value of fat (or any other undesirable nutrient) would be viewed as a quality improvement, if consumers valued fat positively, while from the perspective of a dietician, such an increase would be viewed as a quality decline (see, for example, Harris, 1997). The hedonic method allows us to obtain the value of nutritional quality and nutritional quality change from a consumer viewpoint and can be used, for example, as a tool for evaluating consumer welfare changes resulting from implementation of government policies. It does not, however, provide a measure of objective nutritional quality or quality change.

A second problem with the hedonic approach concerns including only significant coefficients in the calculation of quality change indexes. Considering that multicollinearity is present between nutritional characteristics, some nutrients may be insignificant because of collinearity and not because consumers do not value

them. This can give inaccurate calculated values to the indexes. Another potential problem is possible bias in the estimates of the hedonic prices resulting from omitted variables and incorrect specification of the functional form.

The Healthy Eating Index

The Healthy Eating Index was developed by the USDA Center for Nutrition Policy and Promotion (CNPP) to measure how well the diets of Americans conform to the recommendations of the dietary guidelines and the food guide pyramid (USDA, CNPP, 1995). This index provides a single measure of overall dietary quality. It takes into account the foods people are consuming and the amount of variety in the diet, as well as compliance with specific dietary recommendations. Dietary components that were identified include the degree to which a person's diet conforms to the food guide pyramid; total consumption of fat, saturated fat, cholesterol, and sodium; and the amount of variety in a person's 3-day diet. Each of the 10 components has a scoring range of 0 to 10. The total value of the index can range from 0 to 100, where the latter value indicates an excellent dietary quality.

The Healthy Eating Index measures the nutritional quality of an individual's diet. It does not measure the nutritional quality of a specific food product. In its current form, this index cannot be applied to evaluate the nutritional quality of specific food products.

Moorman's Nutritional Quality Index

In her recent work, Moorman (1998) investigated the impact of market information related to the NLEA on the nutritional quality of food product offerings, on the nature of competitive rivalry among manufacturers, and on consumer activism in using information. To measure changes in the nutritional quality of base brands (that is, brands without nutritional positioning), the author calculated an index that showed the overall change to each brand's nutritional composition between 1993 and 1996. More specifically, this methodology compared the levels of 10 selected nutrients between the years examined using 2 separate indexes—1 composed of 5 selected undesirable nutrients and 1 composed of 5 desirable nutrients. The five selected undesirable nutrients were sodium, total fat, saturated fat, unsaturated fat, and cholesterol. Calories were excluded. The five selected desirable nutrients were vitamin A, total vitamin B, vitamin C, calcium, and iron. Protein and fiber were excluded. If an undesirable nutrient decreased or a desirable nutrient increased, a value of +1 was added to the index. If an undesirable nutrient increased and a desirable nutrient decreased, a value of -1 was added to the index. Thus, the value of the index ranged from +5, in the case where all undesirable (desirable) nutrients decreased (increased), to -5, in the case where all undesirable (desirable) nutrients increased (decreased). This index of nutritional quality change is constructed as a numerical measure rather than a direct measure of the nutritional value of products.

Padberg's Nutritional Quality Index

Padberg and others (1993) developed an overall nutritional quality index that yields a score of 0-100 for individual food products. The Padberg index was developed to address the absence in the literature of such overall indexes of nutritional quality for food products. Nutritionists have not focused on such measures because their main concern is with the nutritional quality of diets rather than of individual products. The Padberg index was constructed by assigning initial quality points ranging from 0 to 100 for each nutrient level listed on the nutrition label, where the scoring is based on the requirements for nutrient content claims on food product packages included in the new labeling requirements. The step functions that resulted were then smoothed to yield point functions that calculated quality points. These quality points were then weighted by dieticians' views of the importance of specific nutrients to yield an overall index ranging from 0 to 100 of the nutritional quality of specific products (see "Methodology and Data Used").

Evaluation of Approaches

Our objective is to measure average nutritional quality change for food products during the mid-1990's. The Healthy Eating, Mojduszka, and Moorman indexes are not suitable for this purpose. The Padberg index is the only one available that is suitable for this purpose because it does provide a measure of the overall nutritional quality of food products. Hansen's nutrition index does not measure the average overall nutritional quality of food products and is, therefore, not a substitute for the Padberg index. Applying the Padberg index, a simple measure of overall nutritional quality change can be computed. A second approach based on a nutrient-by-nutrient evaluation of nutritional quality change is also presented. This approach can be treated as a substitute for Hansen's measurement technique, although it is not presented in the form of nutrient densities.

Methodology and Data Used

The first measure of nutritional quality change used here is the Padberg index. Calculating Padberg's nutritional quality index consists of three main procedures. In the first procedure, the initial scoring system was designed to assign points according to the quantity of each nutrient listed on the label and to give each nutrient an equal weight. Each nutrient, therefore, has the possibility of receiving 0 to 100 points. Definitions of nutrient content claims as published in the *Federal Register* (1993) were used to establish thresholds for scoring. Each nutrient on the label, except sugars and calories from fat, was considered in the scoring system. For example, if the product qualified under the new regulation to make a high fiber content claim, it received a score of 100 for the fiber content. On the other hand, if it could not qualify to make any fat content claims, it received a score of 0 for that nutrient. The total of quality points was then divided by the number of nutrients to obtain the average initial score for a product. The initial scoring system is summarized in table 1.

Assigning quality points based on the requirements for nutrient content claims alone would require the use of step functions. In the step function, each step would motivate product formulators to add (or subtract) nutrients to reach the nearest threshold awarding the next step of nutritional quality points. These steps could distort the quality index measure. In the second procedure, therefore, the researchers smoothed the step functions by averaging them. With the smooth functions, product formulators get quality points for any nutrient changes—whether near a step or not. The point functions for the nutrients are shown in table 2.

In the third procedure, the authors estimated the relative importance of different nutrients using a survey conducted among dieticians (Kim and Padberg, 1993; Padberg and others, 1993). In other words, the quality points assigned in the second procedure for each nutrient in each product were multiplied by the estimated weights that dieticians implicitly placed on each nutrient. We use Padberg's weights on nutrients in our calculation of the indexes. We assume that the relative ranking of nutrients by their importance has not changed since his survey was conducted in 1993. The weights used are shown in table 2.

The final nutritional quality index is the sum of weighted quality points from each nutrient. Its value ranges from 0 to 100, where 100 indicates excellent nutritional quality. The nutrition quality index for the example product—veal marsala—presented in table 2, is 9.4. The low value of the index reveals a low overall nutritional quality rating of this product. Padberg's index is thus a composite index that measures the nutritional quality of a food product based on important nutrients listed on the label (its overall nutritional profile). This index reflects current scientific understanding of nutrition and dietary recommendations for the average American consumer. The role of the index is to evaluate the overall nutritional quality of a food product as opposed to evaluating the nutritional quality of individual consumer diets.

Table 1—The initial scoring system for food products

	Scoring groups				
Nutrient	100	75	50	25	0
			Nutrient per serving		
Calories	274	275-343	344-412	413-481	>482
Fat (g)	<0.5	0.5-6	7-12	13-19	>20
Saturated fat (g)	<0.5	0.5-1.5	2-3	4-5	>6
Cholesterol (mg)	<2	2-46	47-68	69-89	>90
Sodium (mg)	<80	81-319	320-519	520-719	>720
Carbohydrates (%DV)	>20	19-17	16-14	13-10	<10
Dietary fiber (%DV)	>20	19-17	16-14	13-10	<10
Protein (%DV)	>20	19-17	16-14	13-10	<10
Vitamin A (%DV)	>20	19-17	16-14	13-10	<10
Vitamin C (%DV)	>20	19-17	16-14	13-10	<10
Calcium (%DV)	>20	19-17	16-14	13-10	<10
Iron (%DV)	>20	19-17	16-14	13-10	<10

g = Grams, mg = Milligrams, %DV = Percent of daily value.

In using and evaluating the Padberg index, it is important to recognize that it is one of a large possible family of such indexes that could be constructed. Other researchers may wish to refine the index by adjusting the initial scoring system or weights assigned to each nutrient in the overall score. We view the Padberg index as a good starting point in developing an overall measure of nutritional quality that can be applied on a product-by-product basis. Because the index is one of many possible ones that could be used, the methodology applied here also evaluates quality shifts by investigating changes in individual nutrients in food products. The Padberg index is then used to analyze the nutritional quality of new and exiting food product brands. Finally, market share data are used to produce preliminary weighted Padberg indexes that reflect the nutritional quality of foods purchased by consumers.

The analysis is based on a unique supermarket data set that consists of a complete census of all product offerings in the most popular package size in 20 food categories collected in a superstore in New England. The data provide information on brand names, nutrient content levels, nutrition and health claims made, and product prices for the years 1992-95, 1997, and 1999. This method does not result in data being collected on every product offered for sale in the United States in a particular food category in a given year. However, it does result in data being collected on all the major brands, many minor brands, and private-label products. Here we report results for five selected food categories. The brands included in the data set for 1997, for example, cover 60.2 percent, 87.4 percent, 73.3 percent, 75.8 percent, and 62.5 percent of national sales for the entrees, soup, salted snacks, cookies, and processed meats and bacon categories, respectively. These five categories were selected to range across a spectrum from high to medium levels of formulation and to represent foods that are important in consumer diets. In 1996, these food categories represented about 22 percent of national scanner-tracked food sales (table 3).

The categories were also selected because the most complete nutritional data were available for them. For the data set used here, nutrient content values were missing for products that did not carry a nutrition information panel in a particular year. In addition, information on saturated fat, fiber, and sugar was not required and very often not reported on nutrient content panels in 1992 and 1993. Since Padberg's index is a composite index based on most of the product nutrients listed on the Nutrition Facts label, products with incomplete information had to be excluded from the study. Table 4 reports the number of products in each selected food category and shows the extent of the missing data problem in the years analyzed. Because of the lack of data for the early years, complete analysis for 1992-97 was only possible for processed meats and bacon.[2] The other food categories are analyzed for

[2]For the processed meats and bacon category, information reported on pre-1994 nutrition panels was comparable to that reported on post-1994 panels in that the amounts of only very few nutrients were missing. Therefore, the percentage of usable observations was 73.1 percent in 1992 and 89.5 percent in 1993. For the remaining food product categories, information on pre-1994 panels was not directly comparable with information on post-1994 panels because of missing data for the saturated fat, cholesterol, and carbohydrate variables. The percentage of usable observations was in the 50- to 60-percent range, making analysis of the pre-NLEA period inappropriate.

Table 2—Nutrition index: Example product—Veal marsala

Nutrient	Nutrient per serving	Point functions	Quality points	Weights	Weighted points
Calories	453	232-0.481X	14.1	0.06	0.8
Fat (g)	24	102.56-5.128X	0	.30	0
Saturated fat (g)	13	109-18.15X	0	.17	0
Cholesterol (mg)	182	153-1.7X	0	.03	0
Sodium (mg)	627	112.5-0.156X	14.7	.15	2.2
Carbohydrates (%DV)	4	-100+10X	0	.07	0
Fiber (%DV)	3	-100+10X	0	.09	0
Protein (%DV)	68	-100+10X	100.0	.04	4.0
Vitamin A (%DV)	18	-100+10X	80.0	.03	2.2
Vitamin C (%DV)	11	-100+10X	10.0	.02	.2
Calcium (%DV)	6	-100+10X	0	.04	0
Iron (%DV)	21	-100+10X	100.0	.00005	0
∑ Weighted points = Index value	NA	NA	NA	NA	9.4

g = Grams, mg = Milligrams, %DV = Percent of daily value.
NA = Not applicable.

1994-97 or 1995-97. The alternative of covering the entire period from 1992 through 1997 but using only products with complete information may have created a bias in the quality change analysis. This bias could be serious because products with no information or limited information on their nutritional profiles in the early years might have reformulated more than labeled products.

The food categories included under highly formulated products are entrees (including frozen entrees/single-serving dinners, frozen entrees/family pack, shelf-stable entrees, and frozen pizza) and soup. Categories included under medium formulated products are salted snacks (crackers, potato chips, corn chips, and other salted snacks), cookies, and processed meats and bacon. Highly formulated products are defined as those with contents that vary greatly. For example, such products can contain vegetables, meats, cheese, or pasta. The nutritional profiles of those products also vary greatly. Medium formulated products are those with contents and nutritional profiles that are more uniform.

This analysis uses Padberg's index and nutrient-by-nutrient analysis to represent changes in the average nutritional quality of product offerings in each food product category. To indicate the quality of goods that were actually purchased in the market place, the Padberg index was weighted by national sales data. The national sales data used in this study contain information on brands, sales, package size, nutrient content claims, and health claims from a large sample of supermarket scanner data nationwide. These data do not provide information on the amounts of nutrients in food products. Therefore, they cannot be used by themselves for the analysis of nutritional quality change. Instead, information on brand sales from the scanner data must be matched with information on the nutritional quality of the respective brands from the University of Massachusetts supermarket data.

Table 3—Value of U.S. retail scanner-tracked sales for selected food categories, 1996

Food category	Sales	Share of total sales
	Million dollars	*Percent*
Entrees	3,609.0	4.8
Soup	3,157.9	4.2
Salted snacks	2,406.0	3.2
Cookies	2,105.3	2.8
Processed meats and bacon	9,377.5	6.9
Total for food category	20,655.7	21.9
Total national sales	133,462.0	100.0

Source: U.S. National Scanner Data for 1996.

Table 4—Number of products in selected food categories from supermarket data set

	Products in food categories									
	1992		1993		1994		1995		1997	
Food category	Total	Usable	Total	Usable	Total	Usable	Total	Usable	Total	Usable
					Number					
Entrees	—	—	—	—	93	55	92	80	87	75
Frozen entrees/dinners[1]	—	—	—	—	47	30	41	36	41	37
Frozen entrees[2]	—	—	—	—	21	12	24	19	24	17
Shelf-stable entrees	—	—	—	—	11	6	13	12	12	11
Frozen pizza	—	—	—	—	14	7	14	13	10	10
Soup	—	—	—	—	—	—	59	55	69	69
Salted snacks	—	—	—	—	92	81	93	91	107	104
Crackers	—	—	—	—	34	28	32	31	51	50
Potato chips	—	—	—	—	27	26	25	24	21	20
Corn chips	—	—	—	—	14	12	19	19	18	18
Other salted snacks	—	—	—	—	17	15	17	17	17	16
Cookies	—	—	—	—	54	48	51	50	57	57
Processed meats and bacon	67	49	57	51	58	53	54	53	53	52

— = Not available.
[1]Single-serving products.
[2]Multiple-serving products.

Table 5 summarizes the extent of the data match between the two sources. The process of matching information was difficult. The scanner data set includes hundreds of records for every record in the supermarket data set because the scanner data contain records on products in all possible package sizes, flavors, and kinds. Further, although the scanner data set is based on a large sample of stores, it does not encompass the entire population of food products. As a result, specific private-label products that appear in the supermarket data set are missing in the scanner data set and cannot be included in the analysis. Another difficulty arises from the fact that the number of observations in the scanner data is always the same in each year because it is based on the number of brands recorded in the last year the data were collected (in our case 1996). For example, if a product exited the market in 1996, its record will be missing not only in 1996 but also in the earlier years. Approximately 25 percent of the brands from the supermarket data were not in the scanner data.

While the degree of match shown in table 5 is relatively low, we believe our approach yields interesting preliminary insights into the quality of products purchased in the years studied.

Table 5—Summary of supermarket scanner data for selected food categories

	Scanner data					
		Products matched to supermarket data				
Food category	Products, 1992-96[1]	1992	1993	1994	1995	1996[2]
	Number					
Entrees	639	—	—	30	30	32
Soup	518	—	—	—	44	56
Salted snacks	927	—	—	64	67	73
Cookies	707	—	—	28	31	34
Processed meats and bacon	2,006	39	40	40	42	43

— = Not available.

[1]Same each year.

[2]Due to the lack of availability of 1997 data, 1996 scanner data are matched to the 1997 supermarket data.

Changes in the Nutritional Quality of Products Offered for Sale

This section presents measures of nutritional quality change based on the Padberg index and nutrient-by-nutrient analysis for products offered for sale by manufacturers in the five selected food product categories in the years studied. In addition, it presents an investigation of the nutritional quality of entering and exiting brands of food products.

Measure 1: Mean Index Values of Nutritional Quality and Changes in Index Values

Measure 1 involves calculating Padberg index values for each product and then computing mean index values for each food product category and year considered. Then nutritional quality change is measured as the difference in the mean value of the index for each pair of years. Positive and statistically significant changes in the values of the computed quality indexes would imply improvement in the nutritional quality of the food categories examined. On the other hand, negative and statistically significant changes in indexes would suggest a decline in quality.

The calculated mean index values and changes in them are presented in table 6 for food product offerings in the five selected food categories. The years covered vary by product category, depending on the availability of nutrition information. For entrees, salted snacks, and cookies, the indexes for 1994, 1995, and 1997 and their changes were calculated. For soup, the indexes for 1995 and 1997 and their differences were obtained. For these four categories, the analysis covers only the post-NLEA period because information on the nutritional composition of these foods was very incomplete for earlier years. For the processed meats and bacon category, it was possible to compute quality indexes and their changes for each of the years 1992-95 and 1997, which includes both pre- and post-NLEA periods.

Analysis of the point changes in the index values reveals that most of these changes were small during the time period studied and none were statistically significant (see details on next page). For the Padberg index, positive point changes indicate improvements in nutritional quality whereas negative values show a

Table 6—Products offered for sale: Nutrition index values and changes by year and category, selected years, 1992-97

						Changes					
	Mean					Between years				Over longest time periods possible	
Food category	1992	1993	1994	1995	1997	1992-93	1993-94	1994-95	1995-97	1994-97	1992-97
			Index					*Points*			
Entrees	—	—	37.3	36.3	34.7	—	—	-1.00	-1.60	-2.60	—
Frozen entrees/dinners[1]	—	—	36.0	32.2	32.0	—	—	-3.80	-.30	-4.00	—
Frozen entrees[2]	—	—	40.7	39.0	38.0	—	—	-1.70	-1.00	-2.70	—
Shelf-stable entrees	—	—	40.6	43.1	41.7	—	—	2.50	-1.50	1.10	—
Frozen pizza	—	—	31.0	32.6	29.1	—	—	1.50	-3.50	-1.90	—
Soup	—	—	—	47.1	47.9	—	—	—	.80	—	—
Salted snacks	—	—	55.6	56.3	57.7	—	—	.70	1.40	2.10	—
Crackers	—	—	55.8	57.7	58.8	—	—	1.90	1.10	3.00	—
Potato chips	—	—	52.9	50.7	49.5	—	—	-2.20	-1.20	-3.40	—
Corn chips	—	—	57.7	58.2	58.0	—	—	.50	-.20	.30	—
Other salted snacks	—	—	54.8	56.5	56.4	—	—	1.70	-.10	1.60	—
Cookies	—	—	61.8	62.1	61.7	—	—	.30	-.40	-.10	—
Processed meats and bacon	38.8	41.4	41.5	39.8	42.7	2.60	0.10	-1.70	2.90	—	3.90

— = Not available.
[1]Single-serving products.
[2]Multiple-serving products.

quality decline. On average, the indexes for entrees fell consistently over the years studied and rose consistently for soup and salted snacks. The indexes for cookies and processed meats and bacon rose and fell from year to year. In the processed meats and bacon category, nutritional quality improved the most in 1992-93 (a pre-regulation period) and in 1995-97 (a post-regulation period), with the magnitude of the changes being almost the same in both of these periods (2.6 versus 2.9 points). This finding suggests that, at least in this product category, there was no difference in the pace and direction of the nutritional quality change immediately before and after the introduction of the NLEA.

The final three columns of table 6 show index point changes over the longest time periods possible, given the availability of nutrition data. For entrees and cookies, the mean nutritional quality index decreased in the period 1994-97, by 2.6 and 0.1 index points, respectively. For soup in 1995-97, salted snacks in 1994-97, and processed meats and bacon in 1992-97, the changes were positive, equaling 0.8, 2.1, and 3.9 points, respectively.

The nonpooled t-test for two population means was used to test the statistical significance of changes in the mean index values between the examined years. The nonpooled t-procedure requires independent samples and normally distributed populations with standard deviations not necessarily being equal. The assumption of independent samples is essential; the samples must be independent or the procedure does not apply. The nonpooled t-test is robust to moderate deviations from the normality assumption. This test can be applied to large samples from non-normal populations and works reasonably well even for small samples from non-normal populations. The procedure is valid in this case because we are dealing with independent and large samples.

Because the direction of change in nutrition indexes would not be limited to either a positive or a negative change, a two-tailed test is performed for all the comparisons. The nonpooled t-test allows us to reject or fail to reject the null hypothesis that the two population means are the same. For example, rejection of the hypothesis for the observed positive changes in the mean index values for salted snacks would suggest that the positive change in the nutritional quality of salted snacks offered for sale has been statistically significant. Failure to reject the null hypothesis would indicate that, given the information available in the sample, a change in the population index means cannot be inferred.

As noted earlier, the calculated t-test statistics for the nonpooled test have to be based on a large number of observations for each product category. Therefore, for entrees and salted snacks, the tests of significance were performed for the whole category instead of for each subcategory separately. None of the subcategories had enough observations to reliably use the tests of statistical significance. At 95 percent and 90 percent significance levels, the test statistics failed to reject the null hypothesis of equal means of the computed index values for all of the categories and years in question. None of the observed changes in the nutritional quality of food products offered for sale in the categories examined here was statistically significant.

A possible weakness of this analysis is that it relies primarily on means as estimates, so the only condition we are able to account for is the number of observations. It also relies on the t-test to detect significant changes in these means. In addition, Padberg's index does not capture the value of particular food products in a total diet and is not useful for cross-category comparisons. For example, the values of the calculated indexes suggest that the least nutritious foods among those examined here were frozen pizza and frozen entrees. The index values were the lowest for these food product categories and ranged from 29.1 for frozen pizza in 1997 to 40.7 for frozen entrees in 1994. The most nutritious foods were cookies and salted snacks, for which the index values ranged from 49.5 for potato chips in 1997 to 61.8 for cookies in 1994.

In summary, based on the computed quality indexes and their changes, we conclude that the nutritional quality of food products offered for sale by manufacturers did not change significantly in any of the food categories in the years studied during the mid-1990's. For the one food category, processed meats and bacon, for which pre- and post-NLEA implementation data are available, no change in the direction or rate of change in nutritional quality is evident between the two periods. For the other four food categories, the period of analysis in this study may cover too short a time period (1994-97 or 1995-97) to detect significant changes in the nutritional quality of food product offerings. In addition, significant differences in the timing and rate of product change are likely across product categories. The nutritional quality in some cat-

egories may have changed before the period studied (for example, in the late 1980's), while the quality in others may change in the future. Thus, these results should be interpreted as a snapshot of nutritional quality change in the categories and years studied.

Measure 2: Changes in Individual Nutrients

The computed Padberg quality indexes showed little change in nutritional quality for the food product categories considered here. Given that the Padberg index is one of a large family of possible overall quality indexes that could yield somewhat different results, a second method of investigation was also applied to further explore change in the nutritional quality of food products offered for sale. This approach focused on changes in the amounts of individual nutrients listed on the nutrition panels of products. Once again, the nonpooled two-tail t-test was used to detect significant changes in the levels of nutrients. If the changes in the overall nutrition indexes were insignificant but some of the changes in nutrients were significant, it could provide evidence of changes in food product offerings.

Tables 7 through 11 report mean nutrient values per serving and their percentage changes for the five food product categories and the years considered. In terms of percentage change, the mean values for individual nutrient levels in soup, salted snacks, and processed meats and bacon did move in a desirable direction. The levels of undesirable nutrients, such as fat, saturated fat, or cholesterol, decreased, and the levels of desirable nutrients, such as vitamins, calcium, and iron, increased. Specifically, in soup, the level of fat,

Table 7—Entrees offered for sale: Mean nutrient values per serving, 1994-97

	Mean			Change		
Nutrient	1994	1995	1997	1994-95	1995-97	1994-97
	----------Nutrient per serving----------			*----------Percent----------*		
Calories	311.9	309.6	323.9	-0.7	4.6	3.9
Fat (g)	13.1	13.2	14.7	1.0	11.1	12.2
Saturated fat (g)	4.8	4.8	5.3	1.0	9.6	10.6
Cholesterol (mg)	37.6	36.7	36.9	-2.4	.5	-1.9
Sodium (mg)	777.3	782.2	803.6	.6	2.7	3.4
Carbohydrates (%DV)	11.1	10.9	11.2	-1.7	3.0	1.3
Fiber (%DV)	12.1	10.9	12.6	-9.4	15.1	4.3
Protein (g)	15.1	14.3	15.1	-4.8	5.4	.3
Vitamin A (%DV)	12.0	10.4	13.1	-13.0	25.6	9.3
Vitamin C (%DV)	6.3	4.9	6.4	-21.3	29.7	2.1
Calcium (%DV)	12.8	12.0	11.7	-6.1	-2.8	-8.8
Iron (%DV)	9.7	9.9	8.3	2.4	-16.8	-14.8

g = Grams, mg = Milligrams, %DV = Percent of daily value.

Table 8—Soup offered for sale: Mean nutrient values per serving, 1995-97

	Mean		Change,
Nutrient	1995	1997	1995-97
	--------Nutrient per serving--------		*Percent*
Calories (g)	133.0	126.0	-5.3
Fat (g)	4.4	3.9	-11.4
Saturated fat (g)	1.6	1.4	-12.5
Cholesterol (mg)	13.5	12.1	-10.4
Sodium (mg)	526.6	510.8	-3.0
Carbohydrates (%DV)	46.5	43.9	-5.6
Fiber (%DV)	6.3	5.8	-7.9
Protein (g)	5.2	4.9	-5.8
Vitamin A (%DV)	18.6	14.8	-20.4*
Vitamin C (%DV)	16.9	14.4	-14.8
Calcium (%DV)	2.9	2.7	-6.9
Iron (%DV)	6.1	6.1	0

g = Grams, mg = Milligrams, %DV = Percent of daily value.
*Significant at the 90-percent level.

Table 9—Salted snacks offered for sale: Mean nutrient values per serving, 1994-97

Nutrient	Mean			Change		
	1994	1995	1997	1994-95	1995-97	1994-97
	Nutrient per serving			*Percent*		
Calories (g)	129.3	123.1	122.5	-4.8	-0.5	-5.3
Fat (g)	6.5	5.2	5.1	-20.0	-2.0	-21.5*
Saturated fat (g)	1.2	.9	.8	-25.0**	-11.1	-33.3**
Cholesterol (mg)	.5	.4	.4	-20.0	0	-20.0
Sodium (mg)	210.0	198.0	201.4	-5.7	1.7	-4.1
Carbohydrates (%DV)	27.7	25.8	24.8	-6.9	-3.9	-10.5
Fiber (%DV)	1.8	1.8	1.7	0	-5.6	-5.6
Protein (g)	2.3	2.1	2.2	-8.7	4.8	-4.4
Vitamin A (%DV)	.2	.3	.3	50.0**	0	50.0**
Vitamin C (%DV)	5.8	5.6	5.2	-3.5	-7.1	-10.3
Calcium (%DV)	2.1	2.0	2.3	-4.8	15.0	9.5
Iron (%DV)	3.9	4.1	4.5	5.1	9.8	15.4

g = Grams, mg = Milligrams, %DV = Percent of daily value.
*Significant at the 90-percent level.
**Significant at the 95-percent level.

Table 10—Cookies offered for sale: Mean nutrient values per serving, 1994-97

Nutrient	Mean			Change		
	1994	1995	1997	1994-95	1995-97	1994-97
	Nutrient per serving			*Percent*		
Calories (g)	117.2	116.2	117.2	-0.9	0.9	0
Fat (g)	4.1	3.9	4.1	-5.1	4.6	-.7
Saturated fat (g)	1.4	1.3	1.5	-5.0	11.3	5.7
Cholesterol (mg)	2.5	2.9	2.2	16.4	-24.1*	-11.6
Sodium (mg)	98.3	96.8	90.2	-1.5	-6.8	-8.3
Carbohydrates (%DV)	6.4	6.5	6.3	.5	-3.4	-3.0
Fiber (%DV)	3.5	3.4	2.9	-2.8	-16.9	-19.3*
Protein (g)	2.1	1.6	1.4	-24.9*	-13.8	-35.2*
Vitamin A (%DV)	.7	.6	.6	-11.1	-6.3	-16.7
Vitamin C (%DV)	.1	0	.1	0	0	0
Calcium (%DV)	.3	.5	.4	42.4*	-19.1*	15.2
Iron (%DV)	3.4	3.7	3.5	6.4	-3.6	2.6

g = Grams, mg = Milligrams, %DV = Percent of daily value.
*Significant at the 90-percent level.

Table 11—Processed meats and bacon offered for sale: Mean nutrient values per serving, 1992-97

Nutrient	Mean					Change				
	1992	1993	1994	1995	1997	1992-93	1993-94	1994-95	1995-97	1992-97
	Nutrient per serving					*Percent*				
Calories (g)	98.4	91.9	103.3	107.5	95.9	-6.60	12.40	4.10	-10.80	-2.50
Fat (g)	8.1	7.6	8.1	8.7	7.4	-6.20	6.60	7.40	-14.90	-8.60
Saturated fat (g)	3.6	3.3	3.2	3.5	2.9	-8.30	-3.00	9.40	-17.10*	-19.40*
Cholesterol (mg)	23.1	22.0	25.3	26.2	24.1	-4.80	15.00	3.60	-8.00	4.30
Sodium (mg)	376.0	360.0	422.4	441.1	430.8	-4.26	17.30*	4.40	-2.30	14.60
Carbohydrates (%DV)	6.5	.9	1.4	1.0	1.5	-86.20**	55.60**	-28.60**	50.00**	-76.90**
Fiber (%DV)	0	0	.1	0	0	0	0	0	0	0
Protein (g)	5.2	4.9	6.0	6.3	6.0	-5.80	22.50*	5.00	-4.80	15.40*
Vitamin A (%DV)	.6	.6	1.1	.6	.1	0	83.30**	-45.50**	-83.30**	-83.30**
Vitamin C (%DV)	2.1	2.0	2.3	2.5	2.3	-4.80	15.00	8.70	-8.00	9.50
Calcium (%DV)	.4	1.2	1.2	1.0	.7	20.00*	0	-16.70*	-30.00**	75.00**
Iron (%DV)	.6	2.3	2.3	2.7	2.2	28.30**	0	17.40*	-18.50*	26.70**

g = Grams, mg = Milligrams, %DV = Percent of daily value.
*Significant at the 90-percent level.
**Significant at the 95-percent level.

saturated fat, and cholesterol decreased by 11 percent, 12 percent, and 10 percent, respectively, between 1995 and 1997. In salted snacks, the levels of these three undesirable nutrients were lower by 21 percent, 33 percent, and 20 percent, respectively, in 1994-97. In the processed meats and bacon category, fat and saturated fat declined by 9 percent and 19 percent, respectively, in 1992-97. But another undesirable nutrient, sodium, increased by 15 percent. Also, calcium and iron (desirable nutrients) increased by 75 percent and 27 percent, respectively, for this food category in the examined period. Carbohydrates declined by 77 percent. The major changes in entrees from 1994 to 1997 were a 12-percent increase in fat and an 11-percent increase in cholesterol. In cookies, the mean value of cholesterol decreased by almost 12 percent in 1994-97 and sodium decreased by 8 percent. However, at the same time, the average fiber content fell by 19 percent.

Most of the changes were found to be statistically insignificant using the nonpooled t-test at the 95-percent level. The only significant changes at the 95-percent level were in saturated fat and vitamin A in salted snacks and in carbohydrates, vitamin A, calcium, and iron in processed meats and bacon. At the 90-percent level, the number of statistically significant changes in nutrients increased. These additional significant changes are in the following nutrient contents: vitamin A in soup, fat in salted snacks, fiber and protein in cookies, and saturated fat and protein in processed meats and bacon. In general, if nutrient contents changed significantly, increases in desirable nutrients were offset by increases in undesirable nutrients or decreases in undesirable nutrients accompanied decreases in desirable nutrients.

Overall, the nutrient changes and the index value changes suggest that the average nutritional quality of foods offered for sale did not improve significantly in the examined period, except for the salted snacks and processed meats and bacon categories, where the levels of fat, saturated fat, and carbohydrates declined and the levels of protein, vitamin A, calcium, and iron increased significantly.

Nutritional Quality of Entering and Exiting Brands

To provide another perspective on developments in nutritional quality, we examined the mean Padberg index values of entering and exiting food product brands. Table 12 reports the mean index values for all the brands that entered and exited the five food product categories between 1994 and 1995 and between 1995 and 1997. These periods were chosen because they reflect similar trends in the earlier time periods and have the largest number of observations. Data availability

Table 12—Nutrition index values for entering and exiting brands offered for sale, 1995 and 1997

Product	1995[1]		1997[2]	
	Mean	Observations	Mean	Observations
	Index	*Number*	*Index*	*Number*
Entrees	36.30	74	34.70	76
Entering products	43.00	18	46.99	12
Exiting products	40.00	4	48.00	10
Soup	47.10	55	47.90	69
Entering products	50.80	10	49.70	12
Exiting products	47.70	6	48.00	8
Salted snacks	56.30	91	57.70	104
Entering products	58.50	21	59.20	18
Exiting products	56.90	12	58.40	10
Cookies	62.10	50	61.70	57
Entering products	63.90	10	64.33	10
Exiting products	62.89	8	69.55	3
Processed meats and bacon	39.80	53	42.70	52
Entering products	40.70	11	43.50	10
Exiting products	40.10	9	43.10	7

[1]Product entry and exit measured from 1994 to 1995.
[2]Product entry and exit measured from 1995 to 1997.

improved in 1995 and 1997 because almost all products were labeled and information on their nutritional composition was fully available. However, the sample sizes of entering and exiting products are too small to test for statistical significance.

For the soup, salted snacks, and processed meats and bacon categories, the nutritional quality index of the products that entered the supermarket was higher than for those that exited in 1995 and in 1997. This would imply an improvement in the average quality. On the other hand, for entrees and cookies, the entering brands were more nutritious than the exiting brands in 1995, while the reverse was true in 1997. This in turn would imply a decrease in average quality in 1997. The above findings are consistent with the pattern of change in overall index means for these categories.

Note that, for all of the categories considered, both the entering and exiting brands had higher nutrition index values than the category as a whole. These higher values suggest that changes in food products offered for sale at the supermarket are among brands that are more nutritious than average. While findings reported by Frazão and Allshouse (1996) and others show that the number of new nutritionally improved versions of products is growing, the results shown here suggest that this expansion may be offset by exits of products with better than average nutrition profiles. This is reflected in the mean index values, which exhibited little change in the nutritional quality of food products offered for sale. It is unclear whether the pattern of product churn found here is common or may reflect a period of post-NLEA instability.

Summary of Findings: Food Products Offered for Sale

The calculated nutritional quality indexes were used to measure changes in the mean nutritional quality of food product offerings in five selected food product categories: entrees, salted snacks, and cookies in 1994-97, soup in 1995-97, and processed meats and bacon in 1992-97. For entrees and cookies, the changes in the mean values of the indexes were negative, suggesting that the average nutritional quality of these foods decreased from 1994-97, but the changes were statistically insignificant. In turn, for soup in 1995-97, salted snacks in 1994-97, and processed meats and bacon in 1992-97, the changes in the indexes were positive, suggesting that the average nutritional quality of these products increased, but here again, the changes were statistically insignificant. In the processed meats and bacon category, increases in nutritional quality were largest in 1992-93 (pre-NLEA period) and in 1995-97 (post-NLEA period). The magnitude of the changes were comparable in both periods, suggesting that, at least for processed meats and bacon, the pace and direction of nutritional quality change was the same before and after the introduction of the NLEA. However, the changes in the nutrition indexes were statistically insignificant for processed meats and bacon.

The analysis of changes in the indexes was extended by investigating changes in individual nutrients and the nutritional quality of entering and exiting food product brands. The results reveal similar trends and support the index analysis. The mean values for individual nutrient levels in soup, salted snacks, and processed meats and bacon showed changes in a desirable direction. The levels of undesirable nutrients, such as fat, saturated fat, and cholesterol, decreased, and the levels of desirable nutrients, such as vitamins, calcium, and iron, increased. However, most of the changes were found to be statistically insignificant. The only significant changes at the 95-percent level were in saturated fat and vitamin A in salted snacks and in carbohydrates, vitamin A, calcium, and iron in processed meats and bacon. At the 90-percent level the only significant changes were in vitamin A in soup, fat in salted snacks, fiber and protein in cookies, and saturated fat and protein in processed meats and bacon.

For all of the food categories considered, both the entering and exiting brands had higher index values than their categories as a whole, suggesting that, in the immediate post-NLEA period, entry and exit was taking place among brands that were more nutritious than average. This is consistent with the overall finding of little change in the average nutritional quality of food product offerings in the years studied.

Changes in the Nutritional Quality of Food Products Purchased

The analysis of nutritional change in products offered for sale at the supermarket does not address directly the issue of the nutritional quality of food products that were actually bought by consumers. Sales data are required to determine whether the nutritional quality of foods purchased changed in the examined period. To incorporate sales information, the Padberg index analysis was extended by calculating the market share of each brand in the supermarket data for each year based on its national sales values. Total national sales of the brands in the supermarket data were used as the universe for market share calculations for individual products. Market shares were then multiplied by the brand-level nutrition index values to obtain individual weighted values. The sum of these values gave the market share-weighted average nutrition index. Weighing by the market share of each brand rather than using the unweighted index takes into account not only what was offered for sale by manufacturers but also what was sold.

The sales-weighted index results presented here should be interpreted as preliminary due to limitations in the data used. As noted above, it was necessary to calculate the weighted results using products included in the supermarket-based nutrition data and sales from national scanner data. Differences in the two data sources resulted in unmatched data, which made tests of statistical significance impractical. Therefore, the results in this section are preliminary, while showing how the methodology can be used.

Mean-Weighted Index Values of Nutritional Quality and Quality Change

Table 13 shows the unweighted mean nutrition index values for the matched products between the supermarket and scanner data sets. Table 14 shows the market share-weighted nutrition index values and changes in values for these same matched products in the selected food product categories and time periods. In every case, the market share-weighted index values are smaller than the unweighted mean index values for the matched products. This suggests that, for this data set, sales were higher for food products that had poorer than average nutritional profiles. The decline observed in the market share-weighted index values for entrees and cookies also suggests that the average nutritional quality of products purchased by consumers in these

Table 13—Unweighted nutrition index values and changes by year and category for matched products purchased, selected years, 1992-97

	Mean unweighted index					Point changes					
Food category	1992	1993	1994	1995	1997	1992-93	1993-94	1994-95	1995-97	1994-97	1992-97
Entrees	—	—	38.8	36.5	35.3	—	—	-2.30	-1.20	-3.50	—
Soup	—	—	—	46.8	47.4	—	—	—	.60	—	—
Salted snacks	—	—	54.9	56.0	57.2	—	—	1.10	1.20	2.30	—
Cookies	—	—	62.8	62.4	61.4	—	—	-.40	-1.00	-1.40	—
Processed meats and bacon	39.0	41.6	41.3	40.8	42.7	2.60	-0.30	-.50	1.90	—	3.70

— = Not available.

Table 14—Market share-weighted nutrition index values and changes by year and category for matched products purchased, selected years, 1992-97

	Weighted index					Point changes					
Food category	1992	1993	1994	1995	1997	1992-93	1993-94	1994-95	1995-97	1994-97	1992-97
Entrees	—	—	32.3	29.8	29.1	—	—	-2.50	-0.70	-3.20	—
Soup	—	—	—	41.9	42.3	—	—	—	.40	—	—
Salted snacks	—	—	49.7	50.4	51.0	—	—	.70	.60	1.30	—
Cookies	—	—	58.5	58.2	58.0	—	—	-.30	-.20	-.50	—
Processed meats and bacon	33.3	34.8	35.3	34.8	36.1	1.50	0.50	-1.50	1.30	—	2.80

— = Not available.

food categories was declining over the years studied (table 14). On the other hand, for soup, salted snacks, and processed meats and bacon, the increase in the market share-weighted index values over the entire time period studied implies that the nutritional quality of products purchased by consumers in these food categories was increasing.

To explore the results further for entrees and cookies, where the market share-weighted index values decreased, the brands for all matched products were divided into those with unweighted index values above and below the mean index value. This approach allows us to identify a group of relatively more nutritious and a group of relatively less nutritious products the characteristics of which can be compared. The goal of this part of the analysis is to explain the values of the weighted nutrition index and to show what was happening to the components of the weighted index: unweighted mean nutrition index values, total sales values, and market share values.

Tables 15 and 16 present the measured variables (unweighted mean index, mean price, total sales, mean sales, total market share, mean market share, and number of matched products) for entree and cookie brands in the more and less nutritious groups. The unweighted mean index values show consistent decline between the years 1994 and 1997 for all matched products, as well as for those with above- and below-average index values, with the exception of an increase for below-average cookies. The above/below ratio for mean price reveals similar prices for below- and above-average products in the years studied. The above/below ratio for total sales for entrees is decreasing over the whole period examined. This ratio for cookies shows a decline in 1995 and an increase in 1997. Average sales of entrees and cookie brands show that brands in the below-average group seem to be larger sellers on average than brands in the above-average group.

The below-average entree and cookie products held most of the market share. The above/below market share ratio falls over time, suggesting that, for this data set, the market share of more nutritious products was falling relative to less nutritious products from 1994 to 1997. These results are consistent with the decrease in the market share-weighted index values as well as the relationship of the market share-weighted values to the unweighted mean values for all matched entree and cookie brands. During the period studied for entrees and cookies for the products matched, both average nutritional quality was declining and the market share of products with below-average quality was increasing.

Table 15—Purchased entrees with above- and below-average nutritional quality: Mean index values, prices, sales, and market shares, 1994-97

Variable	1994	1995	1997[1]
		Index	
Unweighted mean index value:[2]			
All matched products	38.80	36.47	35.28
Above-average index value	56.30	52.57	52.08
Below-average index value	24.20	26.00	23.15
Ratio (above/below)	2.33	2.02	2.25
		Dollars	
Mean price:			
All matched products	2.26	2.60	2.70
Above-average index value	2.20	2.70	2.70
Below-average index value	2.30	2.50	2.70
Ratio (above/below)	.96	1.08	1.00
		Million dollars	
Total sales:			
All matched products	334.00	414.00	414.00
Above-average index value	96.00	92.00	89.00
Below-average index value	238.00	322.00	325.00
Ratio (above/below)	.40	.29	.27
Mean sales:			
All matched products	11.10	12.40	12.80
Above-average index value	.75	.60	1.00
Below-average index value	14.00	15.30	14.00
Ratio (above/below)	.05	.04	.07
		Percent	
Total market share:			
Above-average index value	0.30	0.27	0.25
Below-average index value	.70	.73	.75
Ratio (above/below)	.43	.37	.33
Mean market share:			
All matched products	.03	.03	.03
Above-average index value	.02	.02	.02
Below-average index value	.04	.04	.03
Ratio (above/below)	.50	.50	.67
		Number	
Matched observations	30.00	30.00	36.00

[1]Scanner data for 1996 were matched to supermarket data for 1997.

[2]Information from matched products was used for all calculations.

Table 16—Purchased cookies with above- and below-average nutritional quality: Mean index values, prices, sales, and market shares, 1994-97

Variable	1994	1995	1997[1]
		Index	
Mean index value:[2]			
All matched products	62.82	62.41	61.40
Above-average index value	68.27	67.95	67.35
Below-average index value	54.34	54.74	54.70
Ratio (above/below)	1.26	1.24	1.23
		Dollars	
Mean price:			
All matched products	2.31	2.41	2.48
Above-average index value	2.33	2.43	2.44
Below-average index value	2.27	2.37	2.53
Ratio (above/below)	1.03	1.03	.96
		Million dollars	
Total sales:			
All matched products	271.00	330.00	367.00
Above-average index value	79.00	75.00	90.00
Below-average index value	192.00	255.00	277.00
Ratio (above/below)	.41	.29	.32
Mean sales:			
All matched products	11.80	11.70	11.70
Above-average index value	5.60	5.20	6.00
Below-average index value	21.30	20.00	17.40
Ratio (above/below)	.26	.26	.34
		Percent	
Total market share:			
Above-average index value	0.29	0.23	0.22
Below-average index value	.71	.77	.78
Ratio (above/below)	.41	.30	.28
Mean market share:			
All matched products	.04	.03	.03
Above-average index value	.02	.01	.02
Below-average index value	.08	.06	.07
Ratio (above/below)	.25	.17	.29
		Number	
Number of matched observations	35.00	34.00	38.00

[1]Scanner data for 1996 were matched to supermarket data for 1997.

[2]Information from matched products was used for all calculations.

Summary of Findings: Food Products Purchased

To reflect the quality of goods purchased by consumers, nutrition index values must be weighted by national sales data. National sales scanner data were used to calculate the market share of each brand in the supermarket data for each year based on its national sales values. The total national sales of the brands in the supermarket data were used as the universe for market share calculations for individual products. For the matched products, the market share-weighted indexes were smaller in each year than the unweighted mean indexes. This implies that sales were higher for food products that had poorer nutritional profiles. For entrees and cookies, the decline observed in the market share-weighted index values from 1994 through 1997 shows that the nutritional quality of products purchased by consumers in these food categories was declining. For soup, salted snacks, and processed meats and bacon, an increase in the market share-weighted index values shows that the nutritional quality of products purchased by consumers in these food categories was increasing.

Finally, the entree and cookie brands were analyzed in two categories: those products with above-average nutrition index values and those with below-average nutrition index values. The market share ratios of products with above-average to those with below-average nutritional quality support the finding that, for this data set, sales were higher for products with poorer nutritional quality. The relatively less nutritious entree and cookie products gained a higher percentage of market share in each year. From the market share-weighted index values for 1994, 1995, and 1997, we can conclude that not only were sales higher for relatively less nutritious products among entrees and cookies but that the nutritional quality of products purchased by consumers was declining.

Final Remarks

Two approaches were used to measure nutritional quality change for food products offered for sale by manufacturers in the entrees, soup, salted snacks, cookies, and processed meats and bacon food categories in the mid-1990's. Based on the first approach, the Padberg index, changes in the mean values of the index for entrees and cookies were negative but insignificant from 1994 through 1997. On the other hand, for soup in 1995-97, salted snacks in 1994-97, and processed meats and bacon in 1992-97, changes in the indexes were positive but insignificant. In processed meats and bacon, the only category for which data were available for before and after implementation of mandatory nutrition labeling under the NLEA in 1994, the pace and direction of nutritional quality change was the same in the two periods. In this sense, this study confirms that changes in information may confer benefits on the market but that these benefits might be more limited in scope than previously theorized (Moorman, 1998), at least in terms of the mix of products offered for sale. Further, market-level (consumer and producer) responses to nutrition-labeling regulations and their timing might vary from one food product category to another and depend on the level of healthfulness of the entire category (Moorman, 1998; Myers and Alpert, 1977).

The second approach, nutrient-by-nutrient analysis of change, yielded results that supported the index analysis. The mean values for individual nutrient levels in soup, salted snacks, and processed meats and bacon suggested improved nutritional quality. The levels of undesirable nutrients, such as fat, saturated fat, and cholesterol, decreased, and the levels of desirable nutrients, such as vitamins, calcium, and iron, increased. However, most of the changes were statistically insignificant using the nonpooled t-test at the 95-percent and 90-percent levels of significance. If changes in nutrient content were significant, increases in desirable nutrients were offset by increases in undesirable nutrients or decreases in undesirable nutrients accompanied decreases in desirable nutrients.

In both approaches, our analysis focused mostly on the years 1994 through 1997 and did not include all products offered for sale in those years. While other time periods and totally complete coverage of products could yield different results, our snapshot results for the five categories and the years studied suggest that the nutritional content of products offered for sale did not change significantly in the mid-1990's. This result is not inconsistent with active levels of introduction of nutritionally improved products. For all of the food categories considered, both the entering and exiting brands had higher nutrition index values than the categories as a whole. In other words, the food products that entered and exited the market during this period were more nutritious than average brands. This helps to explain why the nutritional quality of the average product examined here did not change significantly as a result of new product entry.

In a preliminary analysis, the index values of individual brands were weighted by market sales shares in order to obtain measures of change in the nutritional quality of foods that were actually purchased by consumers. For our data set, the weighted index values were lower than their unweighted counterparts in all food categories. This shows that relatively less nutritious products had higher sales. Breaking up the entrees and cookie brands into products with above- and below-average nutritional quality provided evidence supporting a decline in the proportion of relatively more nutritious products sold in these food categories. On the other hand, the increase in the market share-weighted index values for soup, salted snacks, and processed meats suggests that the nutritional quality of products purchased increased for these categories. It was not possible to test the statistical significance of changes in the market share-weighted indexes.

Several studies have suggested rapid growth in the availability of food products with improved nutritional profiles in U.S. supermarkets during the 1990's. This report indicates that, for the five food categories of entrees, soup, salted snacks, cookies, and processed meats and bacon, this growth did not result in markedly improved average nutritional quality of food products offered for sale or purchased, at least in the time period of the mid-1990's. In many food product categories, the entry of products with improved nutritional profiles may be offset by exits of products with better than average nutritional quality.

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